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Vol. XXXIV, No. 1 JANUARY, 1940 WHOLE No. 290

PRECISE ASTRONOMIC POSITIONS ON A PROVINCIAL BOUNDARY

By NOEL J. OGILVIE*

ASTRONOMY continues to play an important part in the delineation of Canadian provincial boundaries. During the last nine years, precise determinations of position have been made by the Geodetic Service of Canada in connection with the establishment of a number of lines of this category. The most important of these are the Ontario-Manitoba boundary between Island Lake and Hudson's Bay, the 60th parallel of latitude constituting the northern boundary of Manitoba where it intersects the west coast of Hudson's Bay and the 60th parallel of latitude at the northeast corner of the province of Alberta.

The demarcation of the northerly part of the Interprovincial meridian boundary between Saskatchewan and Alberta was carried out in 1938 by the Saskatchewan-Alberta Boundary Commission. In connection with this work, a precise astronomical determination of position was needed close to the northern extremity of the meridian boundary, to locate the 60th parallel of latitude, defined by law as the northern limit of the provinces of Saskatchewan and Alberta. The history of the precise astronomical position work carried out in connection with this meridian boundary forms an interesting illustration of the practical application of precise field astronomy in the development of a new country. A number of years previous to 1938, several determinations of latitude and longitude were made at other points on the line by officials of the Dominion Observatory.

*Dominion Geodesist, Geodetic Service of Canada; Canadian Commissioner, International Boundary Commission.

A study of the sum total of this astronomical work serves not only to stimulate interest in astronomy, one of the most ancient sciences, but is also of value in the study of isostasy, one of the newer branches of geophysical investigation.

The meridian boundary between Saskatchewan and Alberta extends from the International boundary at latitude 49° northward a distance of almost 761 miles to the 60th parallel of latitude. Prior to 1938, about 690 miles of the line had been opened and marked on the ground. The line was originally started in 1878 at latitude 52°-29′ with a supposed longitude of 110°-00′-00″. The accepted longitude for the point of commencement was not determined by a local astronomical observation. Instead, its value had been computed geodetically from township corner to township corner westerly along certain base lines from the Principal Meridian (longitude 97°-27′-28″.4) of the Land Survey System of Western Canada.

After the line had been projected a considerable distance both southward and northward, a telegraphic determination of longitude was made in 1888 at latitude 53°-43′ by the late Dr. O. J. Klotz giving a value of 110°-00′-15″.61. In 1909 and 1910, Mr. F. A. McDiarmid, then an official of the Dominion Observatory, observed for position on this meridian at latitude 49°-57′ and 53°-17′. The resulting values of the longitude were 110°-00′-16″.43 and 110°-00′-15″.43 respectively. Subsequently, the southern terminus of the boundary was tied in with the geodetic triangulation net adjacent to the 49th parallel. Although the tie was not as precise as might be desired, the resulting value of the geodetic longitude of the southerly end of the line is reasonably accurate and gives a value of 110°-00′-15″.15 computed on the 1927 North American datum.

From these determinations, it is apparent that the line was commenced at a point approximately 16 seconds of arc, (1000 feet) west of 110°-00′-00″, the supposed position in longitude. The projection of the line both northward and southward, under the direction of the Surveyor General of Dominion Lands, was carried on with great care.

In spite of this, one serious error in the prolongation of the line occurred at township 42 (latitude 52°-36′) resulting in the projection of the line for several miles on an incorrect azimuth. As a result of

this error, the whole northerly part of the meridian was displaced 137.9 feet to the westward relatively to the southerly part. This accounts for a change of 2.″24 in geodetic longitude of the line at latitude 52°-36′.

In general, observations for azimuth were made every few nights during the extension of the line. Azimuths accurate to about five seconds of arc were usually secured. When the line was found to have five seconds or more of deviation from the true north, it was deflected to bring it back to the meridian. With the exception of the gross error mentioned above, the average error in azimuth over the entire length of the line should not exceed three seconds of arc.

The lineal measurements of the line were, in general, made with two tapes, one graduated in chains and links and the other in feet. While definite figures on the accuracy attained are not available, it is reasonable to conclude that an average accuracy of 1/5000 was attained over the entire distance.

To find the approximate deviations of the vertical, geodetic values of the latitudes and longitudes of the astronomical stations established on the line have been computed using the southerly terminus as a point of origin. As the theoretical azimuth of 360° and the chainages along the line were used for these computations, it will be appreciated that the resulting deviations of the vertical are approximate values only. Geodetic positions based on triangulation nets are not available for any points on the line except the southern point of origin.

The astronomical stations observed are as follows:—

1888 Onion Lake—Lat. 53°-43′ by Dr. O. J. Klotz.

1909 Lloydminster—Lat. 53°-17′ by Mr. F. A. McDiarmid.

1910 Walsh—Lat. 49°-57′ by Mr. F. A. McDiarmid.

1938 North Terminal—Lat. 60°-00′ by Mr. C. H. Ney.

The Onion Lake determination made in 1888 by Dr. Klotz was a telegraphic determination with Winnipeg as the base station. The eye-and-ear method of observing star passages was employed. Determinations were made on six nights giving remarkably consistent results. The exchanges of telegraphic time signals between Winnipeg and Onion Lake were made by recording on moving tapes the incoming signals relative to the beats of the local sidereal chronometer.

The determinations made in 1909 and 1910 by Mr. F. A. Mc-

Diarmid were telegraphic longitudes with Winnipeg as the base station. Star passages and time signals were recorded on an electric chronograph. Results equal in accuracy to modern radio longitudes were secured, independent determinations being made on five different nights.

The 1938 observations for position by Mr. C. H. Ney at the

The Radium Queen—powerful Diesel tug used on the Athabasca and Slave Rivers.

north end of the boundary (latitude 60°) were made chiefly to determine the exact location of the 60th parallel of latitude. The longitude was observed as a check on the values determined further south on the same line and also as a matter of scientific interest.

To reach the approximate location of the theoretical boundary terminal, the astronomical field party under Mr. Ney proceeded by

boat down the Athabasca and Slave Rivers to Fitzgerald. The remainder of the journey, a distance of 60 miles, was made by aeroplane. Landing on a small lake near the assumed position of the boundary terminus, an approximate position determination was made.

A 3¼" Wild-type instrument was used for the star observations. Two stars were observed in each quadrant at a fixed elevation of 60°, the times of star passages across the horizontal wire of the reticule being recorded on an electric chronograph by a hand-controlled telegraph key. This method of position determination, a

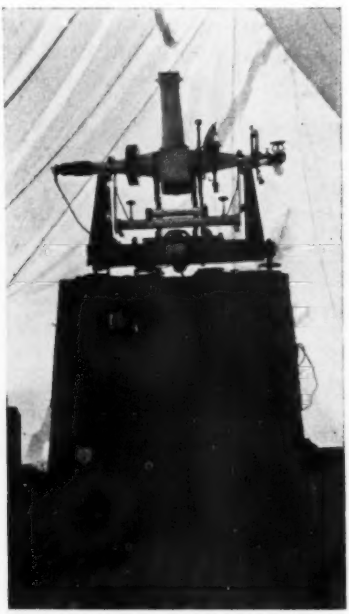
Temporary tent observatory at
Precise Astronomical Station.

modification of the "New Navigation" method of position fixation at sea, is admirably adapted to small field instruments on land. Errors due to abnormalities of vertical refraction are eliminated by observing stars in each of the four quadrants. Moreover the absolute value of the fixed angle of observation need not be accurately known as the method of computation eliminates any error due to a small inaccuracy in vertical circle setting. One or two hours of observation is usually sufficient to make a fixation accurate astronomically to one or two hundred feet.

The calculation of the observations at the base camp showed that the desired location was about a half a mile to the southwest. To find

this point on the ground, a survey line was cut through the thick forest growth on a calculated azimuth and the distance measured with a steel tape.

At the end of the traverse, a tent observatory was erected and the precise astronomical equipment set up. The computation of the ensuing series of precise observations showed a close agreement in



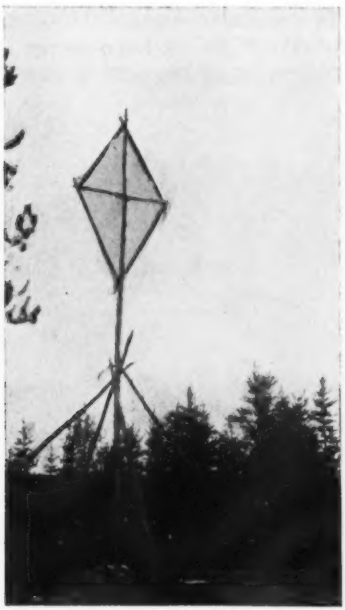
Heyde Astronomical transit used by the Geodetic Service of Canada for precise astronomical position work.

position with the value derived from the short traverse, based on the approximate position determination made at the site of the camp. The difference was somewhat less than 100 feet in lineal distance.

For the precise work, a Heyde astronomical telescope, oriented in the meridian plane, was used for the star observations for both latitude and longitude. The instrument was of the broken-axis type

and was equipped with a travelling transit micrometer. The value of one division of the latitude level was 1.18 seconds of arc.

The accessory equipment included an electric pricker-type tape chronograph, a sidereal and a comparison vernier-type chronometer. The latter was rated to gain one second in fifty on mean solar time



Survey beacon erected over
The Precise Astronomical Station

and was used for the precise reception of the radio time signals. A radio receiver and a small code transmitter, deriving its plate supply from ordinary B batteries, were used for daily communication with the Government radio station at Fort Chipewyan, one hundred miles distant.

Independent determinations of longitude were made on three different nights giving a result accurate to about 10 feet astronomi-

cally on the earth's surface. The determination of the latitude was much more precise. Eighty-one pairs of stars were observed by Talcott's method over six different nights. One pair only was rejected during the computation, which was carried on from day to day during the period of observation.

The resulting value of the latitude of the point of observation was 60°-00′-00″.23 with a probable error of 0.058 seconds of arc. The longitude was 110°-00′-11″.30. A large survey beacon was erected over the concrete pier marking the point of observation and a letter

Transport plane on lake at base camp.

giving the value of the latitude left in a sealed bottle on top of the concrete pier.

In response to a radio message announcing the completion of the operation, a large transport plane arrived the following day and flew the party and equipment to Fort Chipewyan. A few days later, the return journey to Ottawa was commenced.

In completing this special position determination involving a high order of accuracy, Mr. Ney has added one more station to a long series of such points that he has established for the Geodetic Service throughout Canada—stations ranging in latitude from southern Nova Scotia to Ellesmere Island in latitude 76°-12′, 1000 miles north of Hudson's Strait.

Meanwhile 30 miles to the south of the newly established astro-

nomical station, the line-cutting party under Mr. B. W. Waugh, D.L.S., was engaged in the extension of the meridian boundary northward. The neighbouring territory, entirely uninhabited except for an occasional prospector, consisted of alternate stretches of rocky ridges and spruce muskeg. The surfaces of the numerous small lakes and streams almost equalled the land areas and caused considerable difficulty in projecting the meridian northward.

Stone cairn and steel post erected by Mr. B. W. Waugh, D.L.S., at the northern extremity of the Saskatchewan-Alberta meridian boundary.

On September 1st, the line cutters topped the last ridge, worked across a one-mile stretch of muskeg and stopped the cutting. They had arrived at latitude 60°, the northern limit of Saskatchewan and Alberta as indicated by the astronomical pier of the Geodetic Service of Canada.

Being unable to predict the astronomical value of the longitude at the northern end of the meridian, no special effort had been made by Mr. Ney to establish the astronomical pier at any particular value of longitude. The actual value of the pier (110°-00′-11″.30) was the result of an attempt to choose a point considerably west of

110°-00′-00″ yet not quite equal to 110°-00′-16″, the average value of the longitude of the boundary several hundred miles to the south.

The meridian hit 188 feet to the west of the geodetic pier. This lineal offset is the equivalent of 3″.70 in longitude. When added to the value for the pier, it gives an astronomical value of 110°-00′-15″.00 for the longitude of the northern terminus of the line.

The following tables give the astronomic and the approximate geodetic values of the latitudes and longitudes of the four precise astronomical stations established on the boundary line. As pointed out before, the geodetic values computed from the theoretical azimuth and the line chainages are subject to unknown errors. However, at the extreme northerly end of the line the discrepancies in geodetic values should not exceed two seconds of arc.

DEVIATIONS OF THE VERTICAL IN MERIDIAN PLANE

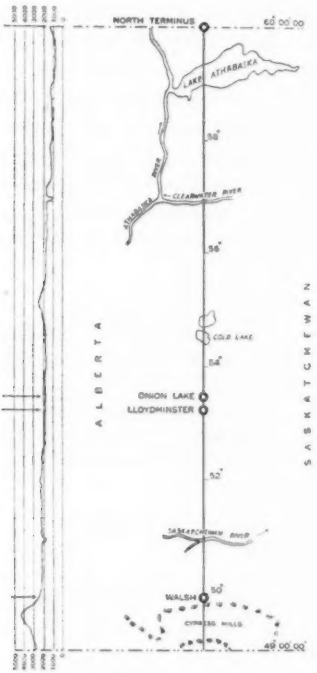
Station	Astronomical Latitude	Geodetic Latitude	Astronomic minus Geodetic
	° ′ ″	° ′ ″	″
North Terminus . .	60−00−00.00	59−59−59.90	+0.10
Onion Lake . . .	53−42−54.53	53−42−53.75	+0.78
Lloydminster . . .	53−16−44.28	53−16−40.13	+4.15
Walsh	49−57−43.95	49−57−37.03	+6.92

DEVIATIONS OF THE VERTICAL IN THE PRIME VERTICAL

Station	Astronomical Longitude	Geodetic Longitude	Astronomic minus Geodetic
	° ′ ″	° ′ ″	″
North Terminus . .	110−00−15.00	110−00−17.39	−2.39
Onion Lake . . .	110−00−15.61	110−00−17.39	−1.78
Lloydminster . . .	110−00−16.43	110−00−17.39	−0.96
Walsh	110−00−15.43	110−00−15.15	+0.28

The tabulated values of the deviations of the vertical in both the prime vertical and meridian planes are small in comparison with values derived in Eastern Canada, where about 145 accurate determinations have been made. The maximum deviation of 6″.92 in the

meridian plane at Walsh on the Saskatchewan-Alberta meridian boundary is approximately one-third of 20″.27, the deflection in the meridian plane at Rivière la Madeleine on the south shore of the St. Lawrence river in the Province of Quebec.



Plan and profile of the meridian boundary between Saskatchewan and Alberta.

The effect of topography on the plumb-line would naturally be small on the Saskatchewan-Alberta boundary. Walsh astronomical station in latitude 49°-57′ giving a deviation of 6″.92 indicates a deflection of the plumb-line towards the south at this point. The reason is quite apparent.

Topographic maps of the area show the Cypress Hills with a maximum elevation of 4546 feet 25 miles to the south of Walsh. Northward, the boundary line extends over the prairie tableland for several hundred miles before passing into the northern bush area which extends a considerable distance north of latitude 60°. This entire area is characterized by the absence of mountains or hills of any great magnitude. In general, the area approximates to a slightly tilted plane sloping towards the east and north.

Perhaps some day in the future, it may be possible to extend a net of primary triangulation over the area adjacent to the Saskatchewan-Alberta boundary. It might even be possible to continue it northward to the arctic sea. Such a net would be of great benefit in the investigation of the size and shape of the earth and in the study of isostasy for the northern part of the North American continent.

SUMMARY OF LATITUDE DETERMINATION AT THE NORTHEAST CORNER OF THE PROVINCE OF ALBERTA IN JULY 1938

Date 1938	No. pairs observed	Mean of Night's Work	Observed Latitude for each pair	Residuals	Residuals Squared
			° ′ ″	″	″
July 9	—	—	59−59−59.97	.26	.0676
9	—	—	61.35	1.12	1.2544
9	—	—	60.76	.53	.2809
9	4	60″.33	59.24	.99	.9801
12	—	—	61.27	1.04	1.0816
12	—	—	60.19	.04	.0016
12	—	—	59.68	.55	.3025
12	—	—	59.37	.86	.7396
12	—	—	60.32	.09	.0081
12	—	—	59.40	.83	.6889
12	—	—	60.04	.19	.0368
12	—	—	60.91	.68	.4624
12	—	—	59.22	1.01	1.0201
12	—	—	61.04	.81	.6561
12	11	60″.20	60.71	.48	.2304
14	—	—	60.35	.12	.0144
14	—	—	60.85	.62	.3844

SUMMARY OF LATITUDE DETERMINATION AT THE NORTHEAST CORNER OF THE PROVINCE OF ALBERTA IN JULY 1938

Date 1938	No. pairs observed	Mean of Night's Work	Observed Latitude for each pair	Residuals	Residuals Squared
			° ′ ″	″	″
July 14	—	—	59.66	.57	.3249
14	—	—	60.97	.74	.5476
14	—	—	60.54	.31	.0961
14	—	—	59.37	.86	.7396
14	—	—	60.48	.25	.0625
14	—	—	59.86	.37	.1369
14	—	—	59 −59 −59.22	1.01	1.0201
14	—	—	60.68	.45	.2022
14	—	—	59.26	.97	.9409
14	—	—	60.19	.04	.0016
14	—	—	61.35	1.12	1.2544
14	14	60″.16	59.41	.82	.6724
15	—	—	60.42	.19	.0361
15	—	—	60.31	.08	.0064
15	—	—	58.92	1.31	1.7161
15	—	—	59.59	.64	.4096
15	—	—	59.96	.27	.0729
15	—	—	59.95	.28	.0784
15	—	—	59.73	.50	.2500
15	—	—	59.96	.27	.0729
15	—	—	61.16	.93	.8649
15	—	—	60.60	.37	.1369
15	—	—	60.98	.75	.5625
15	12	60″.26	61.53	1.30	1.6900
16	—	—	61.26	1.03	1.0609
16	—	—	58.42	1.81	3.2761
16	—	—	59.56	.67	.4487
16	—	—	60.42	.19	.0368
16	—	—	60.59	.36	.1296
16	—	—	59.83	.40	.1600
16	—	—	61.33	1.10	1.2100
16	—	—	60.48	.25	.0625
16	—	—	60.71	.48	.2304
16	—	—	59.73	.50	.2500
16	—	—	60.62	.39	.1521
16	—	—	58.73	1.50	2.2500
16	—	—	59.97	.26	.0676

SUMMARY OF LATITUDE DETERMINATION AT THE NORTHEAST CORNER OF THE PROVINCE OF ALBERTA IN JULY 1938

Date 1938	No. pairs observed	Mean of Night's Work	Observed Latitude for each pair	Residuals	Residuals Squared
			° ′ ″	″	″
July 16	—	—	59.80	.43	.1849
16	15	60″.17	59−59−61.07	.84	.7056
17	—	—	59.98	.25	.0625
17	—	—	59.12	1.11	1.2321
17	—	—	60.97	.74	.5476
17	—	—	58.21	2.02	4.0804
17	—	—	61.21	.98	.9604
17	—	—	58.95	1.28	1.6384
17	—	—	59.90	.33	.1089
17	—	—	61.07	.84	.7056
17	—	—	60.41	.18	.0324
17	—	—	59.89	.34	.1156
17	—	—	61.03	.80	.6400
17	—	—	60.35	.12	.0144
17	—	—	61.08	.85	.7225
17	—	—	61.70	1.47	2.1609
17	—	—	60.49	.26	.0676
17	—	—	60.18	.05	.0025
17	—	—	59.58	.65	.4225
17	—	—	61.85	1.62	2.6244
17	19	60″.34	60.43	.20	.0400
18	—	—	60.88	.65	.4225
18	—	—	60.26	.03	.0009
18	—	—	59.67	.56	.3136
18	—	—	60.33	.10	.0100
18	5	60″.14	59.54	.69	.4761
			60−00−00.23	Σv^2 =	48.00
				p.e. =	0.058

Dominion Observatory,
Ottawa, Ontario.

AN ASTRONOMICAL TRIP TO PARIS

By C. S. Beals

(with Plate I)

DURING the summer of 1939 it was the writer's privilege to attend an International Astrophysical Conference organized by the Fondation Singer-Polignac in Paris for the purpose of studying the subject of Novae and White Dwarf stars. The time of meeting was set for the week of July 17-23 and there were naturally some fears that plans might be upset by the outbreak of war. It turned out otherwise, however, and the members were fortunate to be able to conduct their meetings in an atmosphere of tranquillity which we now know to have been merely a lull before the storm. In this account an attempt is made to present a few general facts concerning the nature of the conference, as well as some of the conclusions which resulted from the discussions.

Paris, the meeting place of the conference, is so often associated in our minds with the world of gaiety and fashion that it is sometimes forgotten that the same city has been a centre of learning for many centuries and that it disputes with Bologna the honour of having the oldest university in Europe.* The meetings of the conference were held not in the University of Paris itself, but in the neighbouring Collège de France, which is now associated with it.

The general idea of such conferences, which have become increasingly frequent of recent years, is to assemble in one place specialists in a particular subject from widely separated scientific institutions, and to hold a series of meetings at which various aspects of the chosen subject are intensively discussed. The Fondation Singer-Polignac had organized a biological conference two years ago. This conference proved so successful that another was organized this year, the choice of an astronomical subject being in part a consequence of the great interest in astrophysical research shown by the late Prince Polignac, the husband of the founder. The personnel of the present conference is indicated in the programme which follows,—

*The University of Paris arose from the cathedral schools around Notre Dame in the early years of the 12th century.

Programme

DU COLLOQUE DE LA FONDATION SINGER-POLIGNAC

PARIS 17-22 JUILLET 1939

Sous la Présidence de M. le Professeur

HENRY NORRIS RUSSELL

Lundi 17 Juillet

Matin

9 h. 30 Séance d'ouverture. Allocutions de MM. FARAL et RUSSELL
Communication de H. N. RUSSELL—Problèmes et buts du Colloque.

Après-midi

3 h. K. LUNDMARK—Parallaxes, motions, and magnitudes of Novae, and their contributions to the study of the scale of the universe.

Mardi 18 Juillet

Matin

9 h. 30 S. GAPOSCHKIN—Novae and SS Cygni Stars.
B. EDLEN—Identification of lines in Nova spectra.

Après-midi

3 h. C. P. GAPOSCHKIN—A spectrophotometric study of novae.

Mercredi 19 Juillet

Matin

9 h. 30 F. J. M. STRATTON—Evolution of nova absorption bands.

Après-midi

3 h. C. S. BEALS—Wolf-Rayet stars, P Cygni stars, and supergiants of class A.

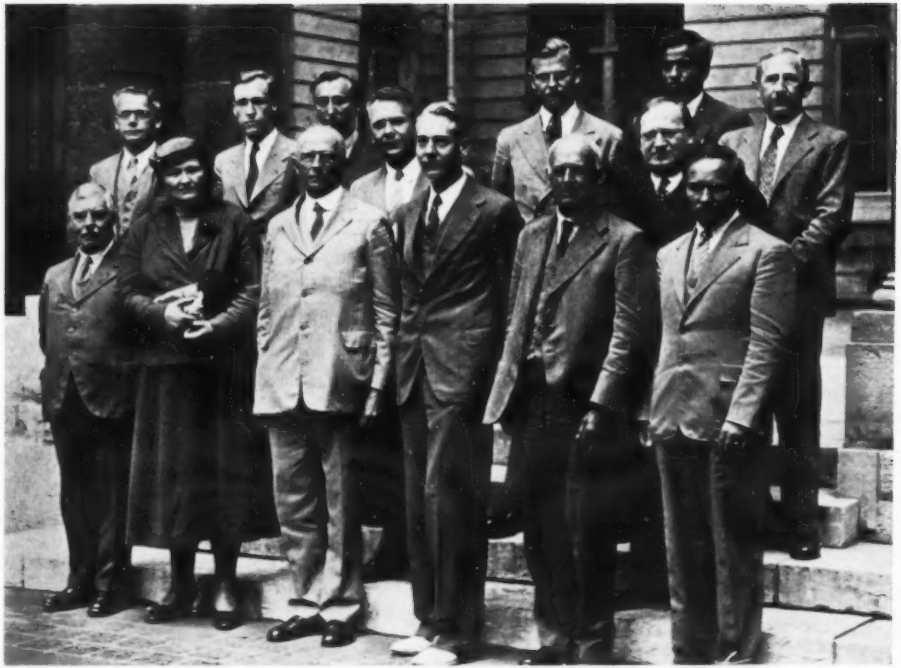
Jeudi 20 Juillet

Matin

9 h. 30 W. BAADE—Supernovae.
B. STRÖMGREN—Theories of the internal mechanism of novae.

Après-midi

3 h. P. SWINGS—Problèmes physique des atmosphères des novae et problèmes des astres présentant des analogies spectrales avec les novae.



MEMBERS OF ASTROPHYSICAL CONFERENCE ON NOVAE AND WHITE DWARFS
Front Row: Stratton, Mrs. Payne-Gaposchkin, Russell, Shaler, Eddington, Gaposchkin.
Back Row: Beals, Edlén, Swings, Kuiper, Strömgren, Lundmark, Chandrasekhar, Baade.

Vendredi 21 Juillet

Matin

9 h. 30 G. P. KUIPER—White dwarfs—observation, discovery, surface conditions.

Après-midi

3 h. S. CHANDRASEKHAR—The White dwarfs and their importance in studies of stellar evolution.

Samedi 22 Juillet

Matin

9 h. 30 SIR ARTHUR EDDINGTON—Theories of white dwarfs. Séance de cloture.

Prof. Henry Norris Russell, whose encyclopaedic knowledge of all branches of astrophysics made him particularly well fitted for the task, acted as chairman, while Mr. Amos J. Shaler, a young student of astrophysics with an excellent knowledge of European languages, acted as secretary and interpreter. English and French were the languages used and each paper was translated, sentence by sentence, as it was delivered. This procedure seemed exceedingly tedious at first, but its advantages were obvious in maintaining the necessary liaison between the French and English speaking members of the conference. The lengthy discussions, which followed the papers, in which all took part, were similarly translated, although when members became particularly animated the translator often had difficulty in stopping them long enough to keep the translation going. It is impossible in brief space to summarize individual papers, but some of the general conclusions may briefly be indicated as follows:—

The subject, novae and white dwarfs, reflected the general currency of the theory, originally due to Milne, that the final state of a nova is a white dwarf star. According to this theory, the energy emitted during the nova outburst is derived from the loss of gravitational potential energy as the main mass of the star collapses from an ordinary configuration to a white dwarf configuration of high density and small diameter. The following arguments stressed by a number of speakers seemed to indicate that in the light of recent observations this theory is no longer tenable.

First, the amount of energy emitted in the form of radiation during a nova outburst is extremely small compared to the loss of gravitational potential energy in passing from a normal to a white dwarf configuration. The typical white dwarf star has a diameter of the order of 1/100 that of the sun and a change of diameter of this magnitude would release thousands of times the energy given out in the typical nova outburst.

Secondly, recent observations, admittedly incomplete, appeared to indicate that the temperature and absolute luminosity of a nova before outburst are approximately equal to those of the same star a few years after outburst, when it had again settled down to a steady state.

Finally, evidence was adduced which suggested that the phenomenon of nova activity was an intermittent one, which could be undergone by the same star many times, the period in some cases being thousands of years so that only one outburst would ordinarily have been recorded. This general conclusion that all novae may be intermittent variables is admittedly speculative but a few such cases are definitely known and they constitute further evidence against associating nova activity with the sudden change of an ordinary star to a white dwarf.

In addition to the above general conclusions, a study of the absolute magnitudes of pre-novae has indicated that novae in general originate from a special class of high temperature stars known as sub-dwarfs having absolute magnitudes several magnitudes fainter than main sequence stars of comparable temperature but still much brighter than the white dwarfs. This conclusion, together with the idea of intermittency already mentioned, has an important bearing on the suggestion, advanced from several quarters on general statistical grounds, that every star in the sky may become a nova at some stage in its history. If novae arise from a special class of stars and if the same star may suffer many outbursts, then it is no longer necessary to suppose that a normal star like the sun may be in danger of a similar catastrophe.

The demonstrated untenability of the "white dwarf" theory of novae made it necessary to consider the possibility of some less deep seated phenomenon capable of producing the observed effects. A

tentative theory was advanced at one of the sessions, in which the effect of a breakdown of radiative equilibrium in layers not far removed from the stellar surface was investigated from this point of view. The conclusion was reached that under certain circumstances such a breakdown might be capable of producing a nova outburst. This provided one possibility for the origin of nova activity but the idea will probably require further development before any final conclusions can be drawn.

In addition to the discussion on the origin of novae, papers were presented dealing with the general characteristics and interpretation of nova spectra, the identification of lines appearing at various stages of nova development and the spectra of certain early type emission stars (the Wolf-Rayet stars, the P Cygni stars and the supergiants of Class A) which were shown to exhibit remarkable analogies with the novae both in their spectra and in the related physical characteristics of temperature and diameter.

One session, devoted to the subject of supernovae, brought out the interesting fact that these remarkable objects have a mean absolute magnitude at maximum of –14.2 which makes them about 600 times as bright as ordinary novae. While it is believed that there has been at least one galactic supernova (Tycho's star which appeared in the year 1572 A.D.) the discussion was based on supernovae discovered in the extra-galactic nebulae. The pre-outburst magnitude of these stars is not known but at maximum they are comparable in brightness to the nebulae in which they appear.

The spectra of supernovae, which are remarkably similar from star to star, consist of broad emission bands which vary in intensity and position with the development of the nova. With the exception of two relatively narrow features which have been identified as due to the forbidden OI lines λ6296 and λ6360, the bands have remained unidentified and the possibility has been considered that they are due to atoms of extremely high ionization potential. One of the speakers presented an ingenious theory in which an attempt was made to account for the supernova bands on the basis of blends of broadened lines due to common atoms of relatively low ionization. The cause of supernova outbursts remains even more obscure than that of ordinary novae.

One of the most interesting observational papers dealt with the white dwarf stars. Notable features were their peculiar spectra, characterized by excessive Stark broadening and low contrast of the absorption lines, and the interpretation of these phenomena as a consequence of small diameter, (of the order of one one-hundredth that of the sun), high density and high value of surface gravity. An additional feature of white dwarf spectra, the Einstein red-shift, due to the same cause, is familiar to all.

The last two sessions were devoted to discussions of the theory of white dwarfs by Sir Arthur Eddington and Dr. S. Chandrasekhar. These discussions were highly mathematical and the two distinguished investigators proved to be in disagreement on a fundamental point concerning the formula representing the physical state of degenerate (extremely dense) matter under the conditions obtaining in a stellar interior. While the informal debate between these well-matched opponents was highly interesting and stimulating, the result, to the less mathematically inclined members of the conference, appeared to be inconclusive, and the outstanding problems of hydrogen content, relation of mass to diameter and the relation of white dwarfs to main sequence stars remained unsettled.

In closing this account of a valuable and stimulating conference, it is fitting to refer to the distinguished hospitality extended to the members by the Fondation Singer-Polignac. The delegates were housed at the Hotel Pont Royal on the left bank of the Seine, not far from the Louvre Gallery. Mademoiselle Alice Mamelsdorf, Professor of the History of Art in the University of Paris, acted as hostess, and her courteous attentions added in innumerable ways to the comfort and enjoyment of the members. The President of the administrative council of the Fondation, M. Edmond Faral, the vice-president, M. Maurice Paleologue, and the secretary general, M. André Mayer, were present at the opening and closing sessions, while the Princess Edmond de Polignac, the founder and honorary president, was present at the final luncheon, where she presented medals to the members and discussed with each one the results of the conference sessions.

The members were privileged to enjoy a further experience of the meaning of French hospitality when they were entertained at

dinner by M. Henri Mineur of the Observatoire de Paris and Mme. Mineur, who is an undersecretary in the French government. This was a really gala occasion. The interest of the gathering was enhanced by the presence of a number of distinguished French scientists, including not only the astronomers Barbier, Chalonge and Dufay, but also the physical chemist Perrin and his son and members of the Curie-Joliot family. The food and wine for which Paris is famous did their part to produce the pleasant mood of friendship and bonhomie with which the gathering came to an end, and the regrets of saying goodbye were tempered by the knowledge that many permanent and valuable scientific and human contacts had been established.

Dominion Astrophysical Observatory,
Victoria, B.C.
December 11, 1939.

A PROPOSAL FOR THE ESTABLISHMENT OF A PRAIRIE TIME ZONE

By R. D. COLQUETTE*

FOR the introduction of time zoning the world is indebted to a Scotch-Canadian, Sir Sanford Fleming, who was only 18 years old when he left his native Kircaldy. He was appointed chief Engineer for Canada at Confederation and had charge of the construction of the Intercolonial Railway. He also conducted exploratory surveys for the Canadian Pacific Railway.

When transcontinental railways were first being pushed across North America there were difficulties regarding time. Noon was when the sun was on the meridian. There was endless confusion among the people and endless arguing among engineers. Fleming, tired of the argument, said he could settle the whole question in half an hour. In this he was mistaken. It took an hour and a half. That was in 1878 and a few years later the Time Zone idea was adopted at an international conference.†

The sun appears to revolve through 360 degrees every 24 hours, or one degree every four minutes. The general principle followed in time zoning is to set the clock back one hour at the edge of each zone, travelling westward. These zones are theoretically each 15 degrees wide, and centred at the 0°, 15°, 30° . . . 75°, 90°, etc. meridian. The first of these central meridians to cross British North America is 60°; the last is 135°. The Central Time zone should, for example, extend from longitude $82\frac{1}{2}°$ to $97\frac{1}{2}°$. But the boundaries of time zones do not necessarily follow the meridians of longitude. In fact, in neither Canada nor in the United States does a time-zone boundary follow its appropriate degree of longitude for any appreciable distance. I stress this point to emphasize that in making time zone boundaries, scientific accuracy is sacrificed, within limits, to human convenience.

In the whole of Canada there is only one boundary between time zones that passes through fully settled territory. Between

*Condensed from the Presidential Address of R. D. Colquette, Winnipeg Centre, R.A.S.C., December 13, 1939.

†It has been pointed out by R. Newton Mayall that Standard Time was outlined some years earlier by Charles F. Dowd. (Editor).

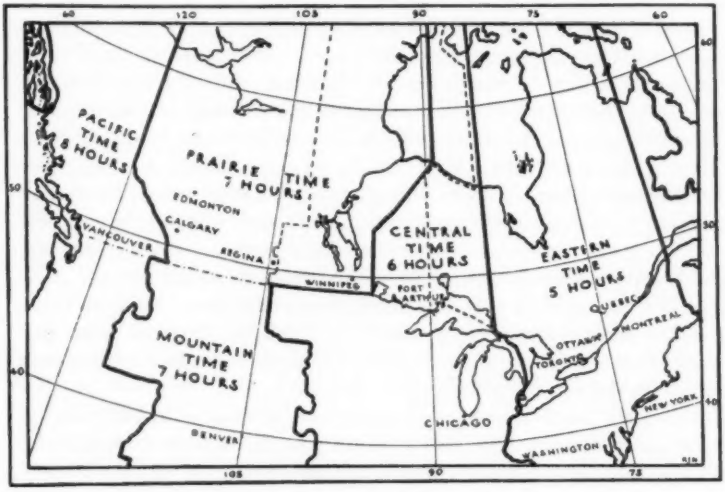
Newfoundland Time and Atlantic Time the line is through the wilderness and over the open sea. Between Atlantic and Eastern Times it is through thinly settled country except where it follows the international boundary. Between Eastern and Central Time the line comes down through wilderness country until it reaches Lake Superior and then follows the international boundary over the Great Lakes to Lake Erie. Between Mountain and Pacific Times the line follows a mountain range and then strikes northward through sparsely settled country.

But there is one exception to this rule and that is the boundary between Central and Mountain Time. It zigzags through fully settled territory from northern Saskatchewan to the international border. The jogs in the line are for the convenience of the railways. Time changes at Broadview on the Canadian Pacific Railway main line. On the Canadian National Railway to Saskatoon it changes at Watrous, which is about 130 miles further west than Broadview. There is a branch railway running northeast from Regina and on that line the time changes at Melville, which is on the same line as Watrous, but on nearly the same longitude as Broadview. On the line just a little north of the Canadian National Railway main line the change is made at Humboldt, which like Watrous, is further west than Regina. The changes are mostly made at divisional points or important junctions.

The proposal I wish to make is that this time change should be shifted from eastern Saskatchewan to the eastern boundary of Manitoba, and that the three prairie provinces should be thrown into one time zone, to be known as *Prairie Time*. The present division is of no special convenience to the railways. In fact it would simplify matters for them if the change were made. The whole western country, from the wilderness playground of northwestern Ontario to the Rocky Mountains would be on the same time. In addition it would be a distinct advantage to business. For example, changes in the time would not interfere with telegraphic or long distance telephone communication. A call made or a telegram sent between four and five o'clock from Regina, Saskatoon, Edmonton or Calgary to Winnipeg would reach its destination before offices closed. If a person in Winnipeg wished to call a friend in Regina at noon, it would be the noon hour in

both cities at the same time. Communication by wire over the prairie provinces would be freed from its greatest inconvenience.

But there is another factor, and a still more important one, which has lately entered into the situation. That factor is radio. To give a concrete example of the difficulty of properly serving vast sections of our population as they should be served by radio, I would like to refer to one piece of service now given by the Canadian Broadcasting Corporation through its 50,000 watt station



Proposed Prairie Time Zone for Canada.
(Solid lines indicate proposed boundaries; broken lines existing boundaries that would be deleted.)

at Watrous, designed to cover the Canadian west. One of the features of the broadcast from Watrous is a farm home program. It is put on from 12.30 to 1 p.m. Mountain Time. It gives a news summary, a report of the grain, livestock and produce markets, and talks on farm problems by recognized authorities, all designed to serve in the best possible way the needs of farm families.

But Watrous is located at the eastern margin of the Mountain Time zone. East of there the country is on Central Time and the program reaches the homes between one and two o'clock instead

of during the noon hour when the family is all in the house. It is of little use to the men members of the family over a considerable area for which the program has been specifically installed.

Another factor which we have to consider is the primary one of sunrise and sunset. In this also, I think the change I am suggesting is a decided advantage. In Winnipeg, for example, we are a little more than seven degrees west of the 90th meridian. That is why, taking sunrise or sunset at that point we have to add 7x4 = 28 minutes to get the times of sunrise and sunset for Winnipeg, standard time. For Portage another five minutes must be added and for Brandon 12 minutes. The sun rises latest, not on December 21, but around the first of the year. On January 1 the sun rises at Winnipeg at 8.27. People going to work at seven or even 7.30 a.m. do so in the night. Even the half-past eighters are in their offices only three minutes after sunrise. At Brandon the sun rises at 8.39 and at some points in eastern Saskatchewan not until about 9 A.M.

Now with the eastern border of the Central Time zone shifted to the Manitoba–Ontario border the sun would rise an hour earlier over the whole of Manitoba and part of Saskatchewan. Even at the latest the sun would rise at 7.27 at Winnipeg and there would be light enough at seven to see the clock without turning on the light. In what is now the Mountain Time zone sunrise would occur at the same time as at present.

But you cannot cheat the sun, nor make him work longer hours for you. What we would gain in the morning we would have to give up in the evening. Under this proposal the earliest sunset would be at 3.26 Winnipeg time. It would be dusk, on clear evenings for about another 55 minutes and darkness would settle around 4.25 instead of at 5.25 as at present.

We now turn to Summer Time. In Winnipeg, around June 20 the sun rises at 4.18 standard time. Under the proposed arrangement it would rise at 3.18. Sunset, during the last few days of June, occurs at 8.41 standard time. Deduct an hour from this and you have it setting at 7.41. Obviously this arrangement could be properly condemned, especially by golfers, who might be expected to turn loose upon it the full striking force of that verbal artillery for which they are famous.

Happily there is a simple way out of the dilemma. It would

be to advance the clock one hour over the three provinces during the summer months. This would bring Manitoba and eastern Saskatchewan back to the present standard time while the present Mountain Time zone would be under what we know as fast time.

I believe that this arrangement would be a great advance over the present division. There is, however, one other possible objection that I should like to refer to. Some might say that the proposed Prairie Time zone would be too wide. A time zone extending from the Ontario–Manitoba boundary to the Alberta–B.C. boundary would be approximately 25 degrees wide or one hour and forty minutes. I have checked the map showing settlement, however, and it puts an entirely different face on matters. Probably 98 per cent or more of the people of the prairie provinces live between longitudes 96 and 115. This is 19 degrees or one hour and 16 minutes wide. Contrasted with this the Eastern Time zone extends from longitude 68 to 90, i.e., 22 degrees or one hour and twenty-eight minutes. In the United States the Central Time zone extends from West Virginia to include the Texas panhandle, an extreme of one hour and thirty-eight minutes, so that Prairie Time zone of one hour and forty minutes, with most of the people living within a range of one hour and sixteen minutes would not show an excessive variation in the rising and setting times of the sun.

But what would happen to the Central Time zone? Its western boundary would be, as we have seen, the Ontario–Manitoba boundary. Its Eastern limit is now longitude 90 in Canada, in reality at Fort William. This would be a pretty narrow time zone; too narrow in fact. My suggestion would be to shift the eastern limit of the zone eastward to Sault Ste. Marie. This would just about bring the central portion in line both with the Northern and Southern portions of it.

I am suggesting this change in the time zones of Canada, believing that it would be of great benefit in transportation, in wire communication and in radio services for this western country. In addition, Manitoba and eastern Saskatchewan would gain an hour's daylight in the morning during the winter months. It is hard to see where, by the change, we would be giving up a single convenience, whereas we would undoubtedly be adding to our convenience in several departments of our everyday life.

Country Guide Magazine,
Winnipeg, Manitoba.

THE WEATHER IN TORONTO—1939

By M. N. Monsinger

THE annual mean temperature in Toronto for 1939 was 47.1° F. or 2.1° F. above the average for the 95 years from 1841 to 1935. Nine months were above average temperature, the exceptions to the general trend being March, April and November. April with a mean temperature deficiency of 1.4° F. was the most below the average of any month. The coldest month of the year was January with a mean temperature of 23.7° F. or 1.1° F. above the average, while the lowest temperature recorded was −8.8° F. on January 26th.

August, with a mean temperature of 72.2° F. or 5.3° F. above the average, was the warmest month, and also showed the greatest mean temperature excess. The absolute maximum of the year occurred in July when a temperature of 93.0° F. was reached on the 7th. A maximum of 86.3° F. was recorded as early as May 6th, and the maximum of 92.1° F., recorded on September 16th, was the highest temperature ever recorded so late in the year.

The year 1939 was the thirteenth consecutive year to show a mean annual temperature above the average of the values recorded. It might be pointed out in regard to the long period mean value that the observations have not always been taken at the same place or with the same instruments.

Precipitation for the year amounting to 27.71 inches was 4.47 inches below the average for the 90 years from 1846 to 1935. February, March, April, and August alone had above average precipitation. The 4.17 inches recorded in August was the largest monthly total and was also the greatest amount (1.39 inches) above the average. Precipitation in November amounted to only 0.32 inches or 2.51 inches below average. This was the least amount in any month and also the most below average.

The total rainfall for the year was 20.74 inches or 5.20 inches below the 90 year average. All months but February, April, and August had below average rainfall. The heaviest rainfall of the year occurred on August 8th and 9th when 3.22 inches of rain fell in six hours, causing extensive flooding of sewers and resulting in

considerable damage to property. This fall has frequently been exceeded in intensity for short periods, but was noteworthy for the amount of rain that fell in so few hours. The only comparable record of such a continuous intense fall occurred on August 4th, 1878, when 3.45 inches fell in four hours.

Snowfall was above the average for the year despite the fact that very little snow fell during the closing months of the year. January, February, March, and April all had more than the average amount of snow. The greatest amount in any one month was 19.9 inches in February, followed by 19.7 inches in March, 19.5 inches in January, and 7.7 inches in April. March was 9.0 inches above the average, the greatest excess of any month of the year. December of 1938 was also above average and the total fall for the winter of 1938-39 was 82.1 inches or 19.9 inches above the average. This was the largest fall in any winter since 1882-83. Despite the large total fall there were no extremely heavy individual snowfalls. The largest fall in any one day was 7.0 inches on April 10th, but snowfalls of 0.1 inch or more occurred on 68 days during the winter.

The late months of 1939 were unusual owing to the lateness of the first snowfall. While a few flakes of snow were observed as early as October 17th no measurable amount of snow fell until a fall of 0.1 inch was recorded on December 15th. Only in 1847 and 1850 have we records of no measurable amount of snow in both October and November, and the only other year comparable to this autumn was 1863 when 0.1 inch of snow fell in November and the next measurable amount of snow fell on December 10th.

The duration of bright sunshine for the year was 2,103 hours or 37 hours above the average for the 50 years from 1886 to 1935. May, July, August, and November had amounts above the 50 year average. August with 51 hours above the average had the greatest excess of sunshine, but the largest monthly total occurred in July when 335 hours or 48 hours above the average were recorded. This number of hours in one month has only been exceeded by the 341 hours in June 1889 and the 354 hours in July 1936. January with 56 hours had the least sunshine of any month.

Dominion Meteorological Office,
Bloor Street, Toronto.

METEOR NEWS

Observations relating to meteors and meteorites are cordially invited.

Meteors Observed in the Transvaal, June–October, 1939

Mr. M. Druker has continued his regular series of meteor observations, carried out at Doornfontein, Johannesburg, Union of South Africa. Those made during June, July and October of 1939 are summarized in the accompanying tables. The first lists

Numbers of Meteors Observed

Date (1939)	S. Afr. L. T.	Total Minutes	Weather Factor	Meteors Observed	Uncorrected Hourly Rate
June 5–6	7.25— 8.00	35	8	4	7
9–10	12.05—12.20	15	8	2	8
14–15	11.55—12.25	30	10	5	10
15–16	11.55—12.25	30	8	5	10
July 17–18	10.20—10.50	30	9	7	14
19–20	9.55—10.25	30	6	6	12
Oct. 8–9	9.12— 9.32	20	7	4	12
15–16	10.38—10.58	20	8	5	15
22–23	9.30— 9.45	15	6	5	20
	Totals ..	225		43	

Magnitude Distribution

Mag.	−4	−2	2	3	4	5	Total	Mean Mag.
Number	1	1	5	11	14	11	43	3.4

Colour Distribution

Colour	r	o	y	yw	w	gy	g
Number	8	6	8	1	15	4	1

the numbers of meteors observed, the final column giving the hourly rates, uncorrected for weather factor. Magnitude and colour distributions are tabulated next. The mean hourly rates are considerably higher than those observed in May of the same year.

Photographic Observations of Meteors in Orillia, April–May, 1939

Mr. Jack Grant in Orillia carried out a series of photographic observations at the time of the Lyrid maximum in 1939. Three cameras were used of speeds F/1.9, F/5.6, and F/8 respectively. Poor weather conditions were encountered on all nights on which the cameras were exposed and no meteor photographs were secured. It is important to attempt to secure photographic data at this

Photographic Meteor Observations in Orillia

Date (1939)	Total Exposure	Weather Factor
Apr. 20–21	9.9 hrs.	8–2
21–22	3.7	3
22–23	0.5	5
May 3–4	1.2	3–4
Total	15.3	

time, however, as relatively few Lyrid photographs have been secured. The shower is not very strong and the weather in April is usually poor for observation. The summary of Mr. Grant's exposures will be found in the accompanying table.

P. M. M.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

Advance in Science in 1939

At the end of each year Science Service, Washington, D.C., prepares a list of outstanding discoveries or other interesting developments in science during the previous twelve months. The following paragraphs, relating to Astronomy and Earth Sciences, are taken from "Science" for December 22, 1939.

Astronomy

The McDonald Observatory 82-inch telescope, second largest in the world was put into use in 1939 on Mount Locke, Texas.

Television apparatus was devised to detect activity in the sun's corona without waiting for total eclipse, promising aid to forecasts of disruptions in inter-continental radio communication.

An unusual number of comets, 6 new and 7 returns of periodic comets found in previous years, were discovered: Kosik-Peltier, Pons-Winnecke (periodic) Vaisala, Jurlof-Achmarof-Hassel (which came to naked-eye brilliance), Kopff (periodic), Schwassmann-Wachmann (periodic), Brooks (periodic), Rigollet, Kaminsky, Tuttle (periodic), Giacobini-Zinner (periodic), Friend, Faye (periodic).

Five more supernovae, tremendous super-exploding stars, were discovered in distant nebulae; occurrence of three such recent outbursts in one nebula within 16 years suggested that in some galaxies a tenth of the stars may explode in a time equivalent to the period since the earth's rocks cooled.

Solar activity remained at a high level during the year, with sun-spots totaling more than 200 on many days, auroral displays of unusual intensity and interference with long-distance radio communication.

Mars made the closest approach to the earth in 15 years, Jupiter came nearer the earth than in 24 years, Saturn came closer to earth than in 20 years.

Two more extremely dense "white dwarf" stars, one with a weight of 9,000 tons per cubic inch, were the first discoveries made with the new McDonald Observatory telescope.

Harvard Observatory's 10,000th variable star was discovered.

A gigantic aura of stars was discovered enveloping our own universe of stars, the Milky Way.

Earth Sciences

A government-sponsored American expedition to Antarctica set sail in 1939, equipped with planes and a specially built snow cruiser, to amass geologic, geographic and oceanographic data and collect zoological specimens and information.

A new method was developed for obtaining geologic data on the deep bottom of the ocean by means of TNT explosions.

A new type of "robot" unmanned observatory made possible the obtaining of weather data in remote and inaccessible places, like exposed mountain tops and the polar regions.

The U.S. Weather Bureau made two innovations: "breakfast time" radio broadcasts and combination aviation and general forecasts made at airfields.

A large iron meteorite was found in Modoc County, California.

There were more than 35 earthquakes of sufficient severity to be registered on the world-wide network of seismographic instruments.

After a nearly normal summer, an unprecedented autumn drought gripped most of the country.

The North Atlantic iceberg season was the longest on record.

The first submarine charts of the eastern coast showing depths out to some 10,000 feet with all soundings incorporated in submarine contours were issued.

A submarine peak, rising nearly two miles above the ocean bottom, was discovered in the Gulf of Alaska.

A new "deepest spot" for the Atlantic, 5.7 miles, was found in the Nares Deep, north of Puerto Rico.

Galileo—"The Star Gazer"

Early in the year 1939 there was published in English translation a volume dealing with Galileo and bearing the title "The Star Gazer". Its author is Harsanyi, a Hungarian, and the original edition in his own tongue appeared in 1936. The work is stated to be "an historical novel in the great tradition" and it merits that description. The author seems to appreciate the nature and significance of Galileo's scientific researches and discoveries and he is well acquainted with the social conditions in Italy and in other European countries at the time.

There is available much documentary material regarding Galileo and where such is missing the author skilfully supplies what is needed. The result is a rounded-out account of the great thinker and his surroundings. As exhibited here Galileo was very acute mentally, of which fact he was well aware. He loved an argument and few opponents could withstand his ruthless logic. Indeed he positively enjoyed thrusting forcibly aside any person who ventured to uphold outworn and fallacious theories. Intellectually he was honest and the famous recantation of the teachings of Copernicus which he was forced to make is to be excused through

his continually recurring bodily illness and his shrinking from pain as he grew older.

Galileo was always in debt. He could not refuse appeals for assistance from his relatives, many of whom were irresponsible worthless parasites. Also, he enjoyed expensive living, including good wines. At one time he is quoted as giving, in a joking way, a list of those people he was then supporting and it came to twenty-six.

It is very interesting to read of the Grand Dukes of Tuscany, the Doges of powerful Venice, the well-known Popes and Cardinals, as well as other famous persons of the Renaissance period, including Shakespeare and John Milton. In 1604 Kepler discovered his new star, and Galileo had communications from him, from Scheiner of sun-spot fame, from Clavius who advised Pope Gregory regarding the calendar, and from others.

One of the dramatic incidents in Galileo's life was his discovery, in January 1610, of Jupiter's satellites with his newly invented telescope. This is described in the book as follows:

> It was one o'clock in the morning of 7th January, when he examined Jupiter. Standing in his frosty solitude, shifting from foot to foot to keep himself warm, he called out suddenly. He saw three very small, but sharply glittering stars in the vicinity of the planet. Nobody had ever known of these stars. They could not even exist, according to Aristotle.
>
> And yet they did. They shone like diamond pinheads along the straight line running parallel with the ecliptic. Galileo left his instrument and stared amazed into the darkness. He took another look. The three diamond points were still there. No, it was impossible. There must be some fault in the lenses. He stared at them for more than an hour and noted down their exact place.
>
> Next day he could scarcely await the sunset. Again he saw the three points, but when he checked by his previous night's drawing their position was different. Or perhaps Jupiter had moved. He rubbed his forehead. It might still be a flaw in the lenses. Next day there was a heavy mist over Padua so he had to break off his observations. But the next night he looked again and thumped on the table. What devilish joke was this? Now he saw only two of the three stars, but in different places. But he saw clearly that this change was not due to the planet. The tiny stars had moved. On the following night there were two again, but a very important thing had happened; last time they had seemed to be completely equal in size, but now one of them was much larger.
>
> He sprang to his feet. Yes, here was the solution. Here were three orbits around Jupiter, just as Venus and Mercury circled round the Sun. One of them was now behind Jupiter, therefore invisible. The second had come forward on

his orbit and therefore looked larger. So therefore Jupiter had its moons! It was a planet like the Earth! If Jupiter was a planet so could the Earth be! The Earth was not the centre of the universe. Copernicus had seen the truth.

He waited for the third star to come out again. On the next night it emerged at about three o'clock in the morning. And another surprise awaited him on the night of 14th January: the fourth star! Three stars were clearly visible west of Jupiter and one to the east. Next night all four were on the west side. No doubts now: Jupiter had four moons, four stars of which astronomy had known nothing! This meant the end of the peripatetics. On their "unchangeable" sky, Galileo had discovered four new stars!

He worked on feverishly at his notes to publish this earth-shattering discovery. His quill raced across the paper. In his introduction he described the invention of the new instrument, and then he built up his observations into a solid system. He left the moons of Jupiter till the end. He scarcely slept four hours a day. He strayed about, dazed as an autumn fly, but when he was back again at his desk, after the effort of the first few sentences, his mind became suddenly clear and eager. Then, while he slept, his manuscript was copied by three clerks.

By 29th January he had finished. His book was called: *Sidereus Nuncius. The Herald of the Stars*. It proclaimed wonders, which all, especially philosophers and astronomers, would have to take into account.

C. A. C.

The Practical Democracy

Members of the Toronto Centre, who are familiar with the versatility of their Chairman, Mr. S. C. Brown, will not be surprised to learn that he is the author of a recently published non-astronomical book on "The Practical Democracy." This book of 125 pages outlines some of the difficulties of our present economic system, suggests ways of remedying these, and discusses consequences of an adoption of these methods. His ideas include substantially a commodity dollar, planned production, and abolition of interest levies. The book is very interesting and thought-provoking; but it is easy to imagine that most of it would encounter serious objections from right-wing economists.

An Honour for a Canadian Meteorologist

Readers of this Journal will be interested to learn that Mr. Andrew Thomson has been elected as the Vice-President of the American Meteorological Society for the two years 1940 and 1941. This society is the largest and one of the most important meteoro-

logical societies in the world, and election to one of its major offices is a tribute to Mr. Thomson's eminence as a meteorologist.

Mr. Thomson, who is at present on the staff of the Meteorological Observatory in Toronto, is Acting Assistant Controller of the Meteorological Service of Canada. He has for years been a very active member of the Toronto Centre of the Royal Astronomical Society of Canada, is also a member of the General Council of our Society.

F.S.H.

MEETINGS OF THE SOCIETY

AT TORONTO

October 17, 1939.—The regular meeting of the Royal Astronomical Society of Canada, Toronto Centre, was held in the McLennan Laboratory, University of Toronto, on October 17, 1939, Mr. S. C. Brown in the chair.

The following were elected to membership in the Toronto Centre:

Mr. Felix A. Belcher, 250 Lisgar Street, Toronto.
Mr. Sydney P. Cash, 190 Brunswick Avenue, Toronto.
Mr. W. R. Dunlop, 307 Riverside Drive, Toronto.
Mr. Robert Forsyth, 168 Strathallan Blvd., Toronto.
Mr. N. S. Philp, 296 St. Germain Avenue, Toronto.

The meeting was a members' open meeting to give the members an opportunity of describing their summer experiences and observations. Mr. Brown first called upon Mr. A. R. Hassard. Mr. Hassard reminded the members that two rather important astronomical events occurred this summer: the near approach of Mars on July 27, and the fall of the Dresden Meteorite on July 11. Mr. Hassard expressed the wish to see Mars and its two satellites and Uranus and its four satellites through a suitable instrument. Mr. Hassard observed the aurora on several nights during the summer; saw a few Perseids; found Mars, Jupiter and Saturn an interesting group in the sky.

The second speaker was Mr. J. R. Collins, who had visited the Lowell and Mount Wilson Observatories during the summer. At the Lowell Observatory Dr. Lampland showed Mr. Collins photographs of the planets. Mr. Collins was particularly interested in those of Mars showing surface details. The staff at Flagstaff seem to be convinced that there is life on the surface of this planet. At the time when Mr. Collins visited Mount Wilson Observatory the object under especial observation was a super-nova, though he did not see photographs of it.

The next speaker was Mr. Patterson, who has been doing quite a lot of observing with his telescope. Mr. Patterson started regular observation of Mars about the middle of June. At that time the planet appeared quite small; at the time of nearest approach the diameter appeared about six times what it was in June. Mr. Patterson distinguished considerable detail on Mars and in the rings of Saturn. Mr. Patterson has also been observing sunspots, and hopes to arrange his equipment so as to be able to take photographs every day at noon. He got a poor view of the Dresden Meteor and described the colour as orange. The meteor was visible for four or five seconds, was not observed to burst, but simply disappeared with very little motion into the haze. In addition Mr. Patterson has been making drawings of the aurorae.

Mr. Brown next called upon Mr. H. G. Duncalfe, who said that one of

his early observations was of Donati's Comet in the autumn of 1858. Mr. Duncalfe invited any of the members and their friends who wished to see through his 6½-inch telescope to come to his home on Thursday, Friday or Saturday nights of the week following the meeting. At that time the moon, and the planets Mars, Jupiter and Saturn were well placed for observation.

Dr. D. W. Best was the next member to speak. His first observation to be recorded was the regularity with which Mr. Patterson comes from Guelph to attend the meetings. Dr. Best then remarked that it is usual to think of the stars rising in the east and setting in the west, but that this summer he had an excellent opportunity of observing that stars do rise in the west and set in the east. It so happened that the contour of the horizon across a lake was such that the star Capella, in its diurnal motion, followed along the horizon. The horizon afforded reference points that made the motion of this circumpolar star from west to east easily observed.

Mr. Brown then asked if any member was prepared to answer the question presented at the last meeting. The two questions to be answered at the next meeting are: I. What planet is most similar to the earth from the standpoint of: 1. Atmosphere. 2. Size. 3. Satellites. 4. Density. 5. Rotation. 6. Surface Gravity. II. Name the 7 elements of a planetary orbit.

Mr. Brown drew the attention of the members to the last meeting of the year, on December 12, an Astronomical "Information Please". He asked that members send their questions to Dr. Millman in care of the Library, 198 College Street.

The second part of the programme was the first of a series of lectures by Dr. F. S. Hogg. The general subject of the series is "Motions—Terrestrial and Celestial". This lecture was a general description of the motions that will be discussed at greater length in the following lectures. These Dr. Hogg arranged in order of increasing difficulty of detection.

1. The stars appear to move from east to west once every 24 sidereal hours, due to the rotation of the earth from west to east.
2. The sun's apparent motion is caused by the revolution of the earth around the sun once a sidereal year.
3. The change of the pole star and the precession of the equinoxes is caused by the conical motion of the earth's axis about the poles of the ecliptic in about 26,000 years.
4. The drift of the stars past the sun is due to the motion of the solar system towards a point near Vega at about 12 miles per second.
5. The apparent motion of the distant stars suggests that the whole galaxy is rotating in a period of 220 million years.
6. A drift of our galaxy, with respect to other nearby galactic systems is not well determined.

The first three motions are detectable without instrumental aid. The others are found by studying the positions of the stars more carefully and analysing the motion into part due to the motion of the observer—terrestrial—and part

due to the actual motion of the object—celestial. The basis by which the apparent celestial motions are so separated is to be studied in these lectures.

After a brief discussion the meeting adjourned.

November 14, 1939.—The regular meeting of the Royal Astronomical Society of Canada, Toronto Centre, was held in the McLennan Laboratory, University of Toronto, on 1939, November 14. Mr. S. C. Brown was in the chair.

The American Association of Variable Star Observers, Harvard College Observatory, Cambridge, Mass., was elected to membership in the section Members at Large.

The speaker of the evening was Prof. A. E. Johns of McMaster University, Hamilton, Ontario. Prof. Johns gave a very interesting lecture entitled "This Runaway Universe". He first discussed the construction of the universe, and then showed why the term "runaway" is applicable.

The smallest of the cosmic units of which the universe is constructed are electrons and protons. The neutral atom contains the same number of each of these units, and is essentially empty, forming a miniature solar system. The molecule is built of atoms and is still a very small object. Matter is being transformed from one thing to another by natural radioactivity and also by bombarding the nuclei of atoms with fast-moving particles. The next cosmic unit is the planet. Prof. Johns pointed out that the earth is an average-sized planet. To help remember the order of the planets from the sun, Prof. Johns suggested the following sentence: Men Very Early Made Jars Stand Up Nearly Perpendicularly. From the laws of probability the chance that all the planets and planetoids should move around the sun in the same direction is so small as to suggest a common origin for them.

The star is the next unit; an average example is our sun. Within a small range all the stars weigh about the same, though there is a great range in brilliance and in size. The galaxy is the next cosmic unit that Prof. Johns considered. Our Milky Way is a sample galaxy. He gave Sir Arthur Eddington's recipe for a galaxy:

Take about 100,000 million stars. Spread them out about four light-years from one another. Add about the same amount of matter in the form of loose dust. Roll out flat and set it spinning in its own plane.

The next unit in order of size is the supergalaxy, or a galaxy of galaxies.

Prof. Johns then considered the motion of each of these objects. A sodium atom, for example, emits about 5 million waves per second, and this radiation travels at the rate of 186,000 miles per second. The molecules of air in the lecture room will be travelling at about one-third mile per second. At our latitude the earth is moving east due to rotation at 700 miles an hour, and is moving 18½ miles a second in its orbit around the sun. The sun, and the earth with it, is moving towards Vega at 12 miles per second. The galaxy is rotating, and the speed of the sun about the centre of the galaxy is 175 miles a second. At this rate it will take the sun some 224 million years to complete one revolution around this centre. It appears that the galaxies are receding from us, and that the farther away they are the faster they will go. This led Eddington to the idea of an expanding

universe, which doubles its radius in 1300 million years. Prof. Johns concluded by quoting from Tennyson:

> Flower in the crannied wall,
> I pluck you out of the crannies,
> I hold you here, root and all, in my hand,
> Little flower—but if I could understand
> What you are, root and all, and all in all,
> I should know what God and man is.

The second part of the programme was a continuation by Dr. Hogg of the observational evidence for the rotation of the earth.

Mr. Duncalfe displayed some patterns obtained from two gyropendulums. After a brief discussion the meeting adjourned.

RUTH J. NORTHCOTT, *Recorder.*

AT VICTORIA

April 19, 1939.—A regular meeting of the Royal Astronomical Society of Canada, Victoria Centre, was held in the Y.W.C.A. Parlours. The president, Mr. R. Peters, was in the chair.

The president read and discussed several inquiries from the question box. One question, Is there any evidence to show that the stars rotate, and if so, what is their period of rotation?, was answered very lucidly by Dr. R. M. Petrie. It was explained that this problem has been solved more exactly since the development of the spectograph and the study of spectographic binaries. Dr. Petrie mentioned some of the work done at the Dominion Astrophysical observatory here, and explained how a study of the spectral lines made it possible to calculate not only the motions, but also the relative brightnesses, sizes and mean densities of the components of a spectographic binary.

Mr. K. O. Wright, in outlining current astronomical phenomena, reported on a new comet of magnitude 3 discovered April 16 by Hassel, a Norwegian. Mr. Wright noted that an occultation of Spica will begin approximately at 8.20, May 1. Zodiacal light, a phenomenon seen particularly well at this time of year, was also explained.

Dr. J. A. Pearce spoke briefly on the remarkable auroral display seen Sunday evening, April 16; he explained how careful observations of the focal point of the aurora enabled one to determine the directions of the magnetic lines of force for Victoria.

The president next introduced the two main speakers of the evening, Mr. J. Smith and Mr. J. Parnall. Mr. Smith presented the affirmative side of the question, Is there life on other planets? This speaker suggested as theories for the origin of life, either (1) spontaneous generation on the earth, or (2) a similar circumstance occurring elsewhere and spores being wafted to our planet. Either theory would suggest the origin of life on any other planet, providing it could be shown that conditions had developed similar to those on

the earth. It was shown that fairly similar conditions did develop on both Mars and Venus, the former being the more favourable. With respect to other planetary systems Mr. Smith pointed out that it is improbable that only one system should be bestowed with rational life.

Taking the negative side of the same question, Mr. Parnall concluded that life on our planet might still be an unique circumstance. He explained that since a multitude of circumstances are required for the development of life, it is likely that the probability of all the circumstances occurring simultaneously would be fairly minute. In dealing with Mars particularly, this speaker pointed out that the so-called "canals" may possibly be due to the atmosphere alone; also that from photographs in infra-red and ultra-violet light, it is shown that the phenomenon of the polar caps probably extends far into the atmosphere. From this and other data Mr. Parnall concluded that there is no possibility of the existence of life as we know it on other planets.

May 3, 1939.—A regular meeting of the Royal Astronomical Society of Canada, Victoria Centre, was held in the Y.W.C.A. Parlours, with the president, Mr. R. Peters, in the chair.

Mr. K. O. Wright referred briefly to current astronomical phenomena, noting particularly the positions and magnitudes of recently discovered comets.

There were several questions from the question box. Dr. C. S. Beals answered the first one, How is the distance between ourselves and the stars measured? Two different methods were explained, first the trigonometrical method, where the star is observed at two different times, and second, the method based on the inverse square law of distance, where the brightness of the star is compared with that of the sun. The second question, How far away is the sun? was answered by Mr. Boyd Brydon. Kepler's laws of motion, said this speaker, enabled astronomers to construct an accurate scale model of the solar system although actual distances were not known. Subsequent investigations, however, fixed the distance between the earth and the sun at roughly 93 million miles.

Mr. William Petrie then introduced the speaker of the evening, Mr. Genille Brown Cave, who had chosen as his topic, The Kinetic Theory of Gases. Mr. Brown Cave explained the modern scientific method of developing a theory, as distinct from that of the earlier Greeks. Boyle's law was discussed as one of the first laws developed in evolving the kinetic theory of gases. The speaker illustrated by experiments and explained the phenomena of fusion and Brownian movement, noting that both are important in the development of the kinetic theory of gases.

Mr. Brown Cave applied the kinetic theory to explain pressure, fusion, Brownian movement, transmission of sound, conduction of electricity. Several deviations from Charles' and Boyle's laws were pointed out, also a few types of curves obtained in working with these laws.

A hearty vote of thanks to Mr. Brown Cave and Dr. Beals for their interesting addresses.

P. RIDDLE, *Recording Secretary.*

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The Small Observatory and its Design, by H. Boyd Brydon, 48 pages; Price 25 cents postpaid.

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